



# Lightening the Load

**Briefing to  
Honorable Delores M. Etter  
Assistant Secretary of the Navy  
(Research, Development and Acquisition)**

**September 2007**

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***“We are careful not to load a mule with more than a third of his own weight.”***

**- Col. S.L.A. Marshall  
*The Soldiers Load (1950)***

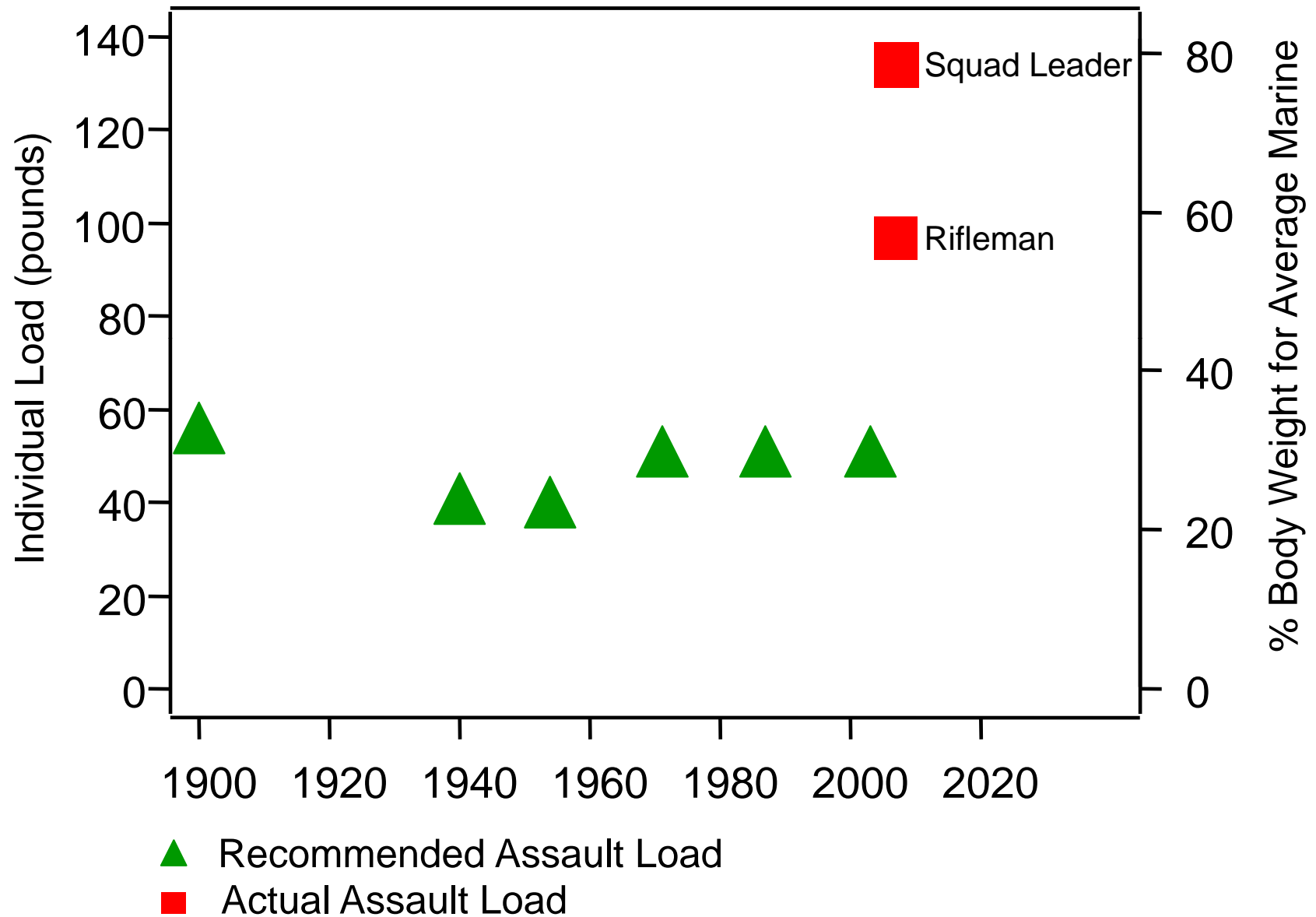


# Lightening the Load





# The Problem





# Outline

- **Problem**
- **TOR**
- **Membership**
- **Study Approach**
- **Options**
  - Lighten the load
  - Transfer the load
  - Enhance human performance
  - Establish a systems approach
- **Recommendations**
- **Actions**





# Terms of Reference: Objectives

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- Assess the elements of the combat load carried by today's Marine
- Identify the primary weight and volume contributors
- Identify and evaluate technology initiatives
- Consider changes in operations, logistics, and training to reduce this burden without having an unacceptable impact on combat effectiveness, safety, or tactics.



# Panel Membership

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VP, L-3 Communications; Former Army Deputy Assistant Secretary and Chief Scientist

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USMC (Ret.), Contractor, Marine Corps Warfighting Lab





# Study Approach

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- Understanding the problem
- Briefings, reports, and discussions
- Sub-panels
  - Reduce the weight
  - Transfer the load
  - Enhance human performance
  - Systems approach
- Analyzed data
- Examined alternatives
- Developed recommendations and actions



# Briefing Topics

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- Overview from Army Science Board, PEO Soldier, Distributed Operations, etc.
- LTL Perspective: Organization/Command/Policy
- LTL Perspective: Allies
- Recent Combat Experience Panels
- Marine Corps and Army Lessons Learned
- Experimentation
- Logistics
- PM Current Equipment Status and Plans
- Training
- Technology: ONR, DARPA, Army, MCWL, etc.



# Marine Rifleman Loads

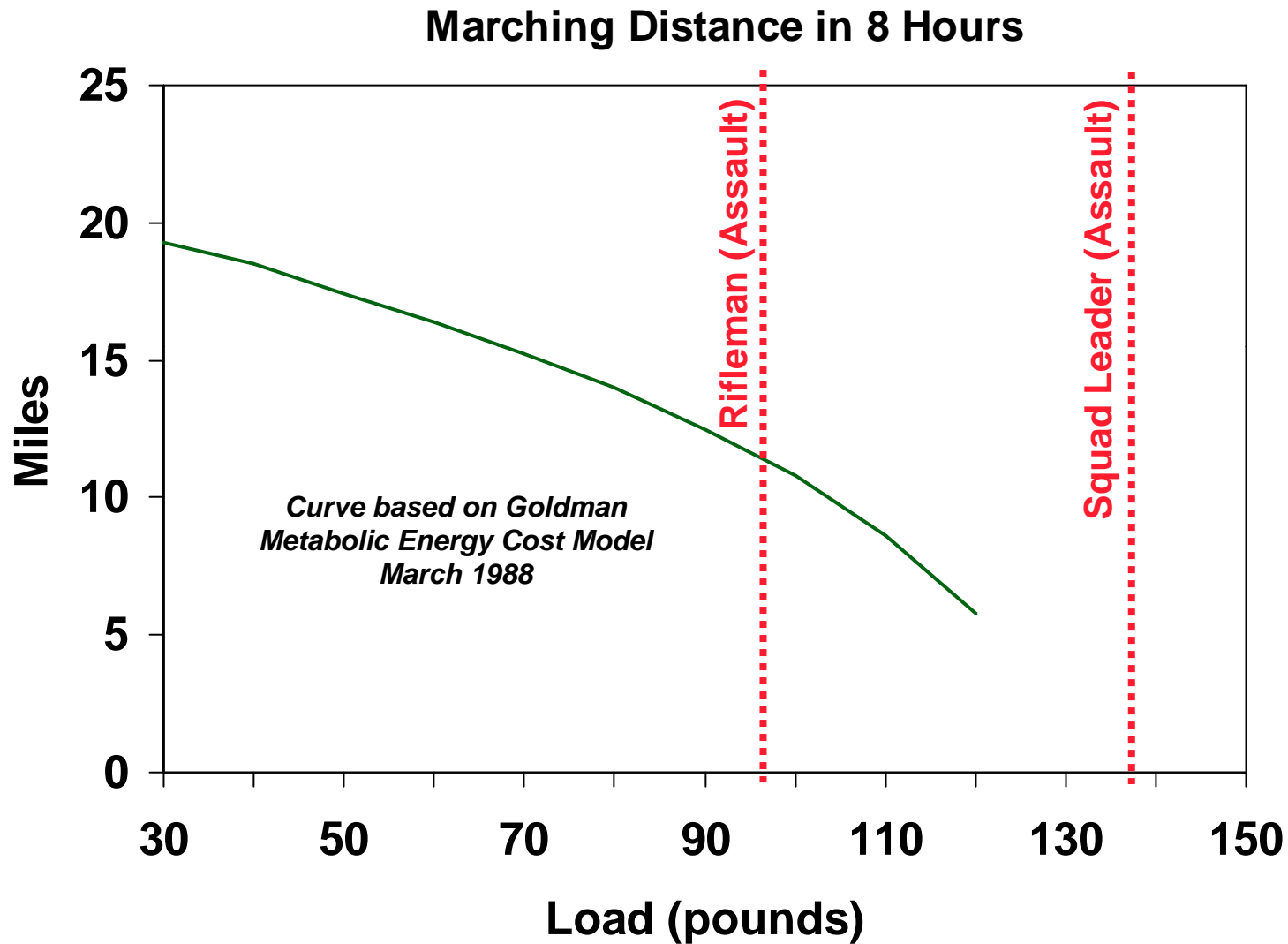
Load Description	Recommended Load*	Current Rifleman's Load**
<b>Assault Load</b> (In the Fight) Conduct combat operations indefinitely with minimal degradation in combat effectiveness	<b>50 lb</b> 30% of body wt based on Avg Marine (169 lb)	<b>97 lb</b> 57% of body wt
<b>Approach March Load</b> (Getting to the Fight) Conduct 20-mile march within 8 hours maintaining 90% combat effectiveness	<b>76 lb</b> 45%	<b>123 lb</b> 73%
<b>Existence Load</b> Limited movement within confines of transportation platforms and limited marching from landing zone into secure area	<b>127 lb</b> 75%	<b>167 lb</b> 99%

\* MIL-STD-1472F

\*\* Information received from MCCDC, Quantico



# Load Impacts Performance





# Marine Rifle Squad



Squad Leader



Fire Team Leader



Assistant Automatic Rifleman



Automatic Rifleman



Rifleman



Medical Corpsman  
(Navy)  
(Attached)



Fire Team Leader



Assistant Automatic Rifleman



Automatic Rifleman



Rifleman

FIRE TEAM

FIRE TEAM



Fire Team Leader



Assistant Automatic Rifleman



Automatic Rifleman



Rifleman

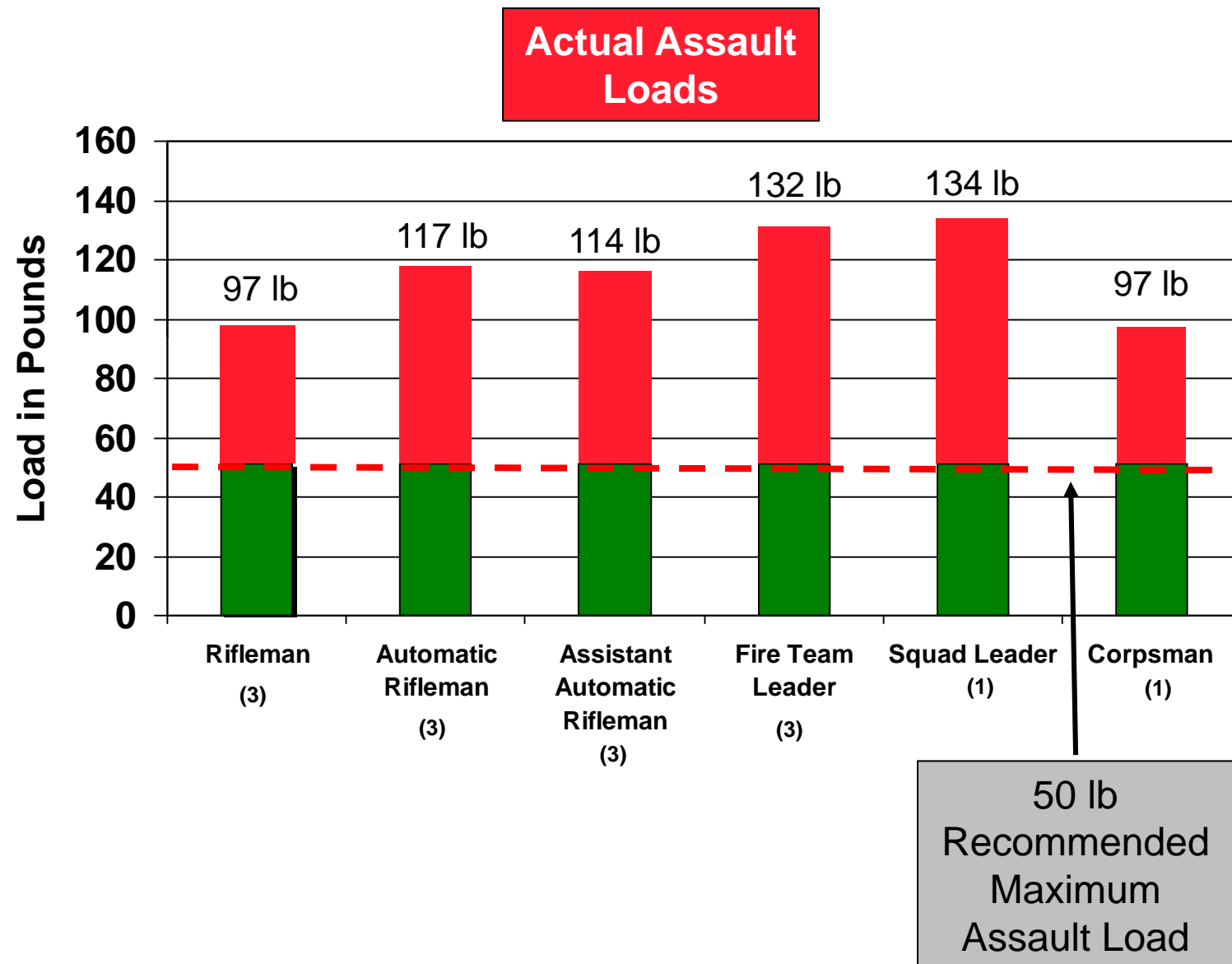
FIRE TEAM

13 Marines plus 1 Corpsman





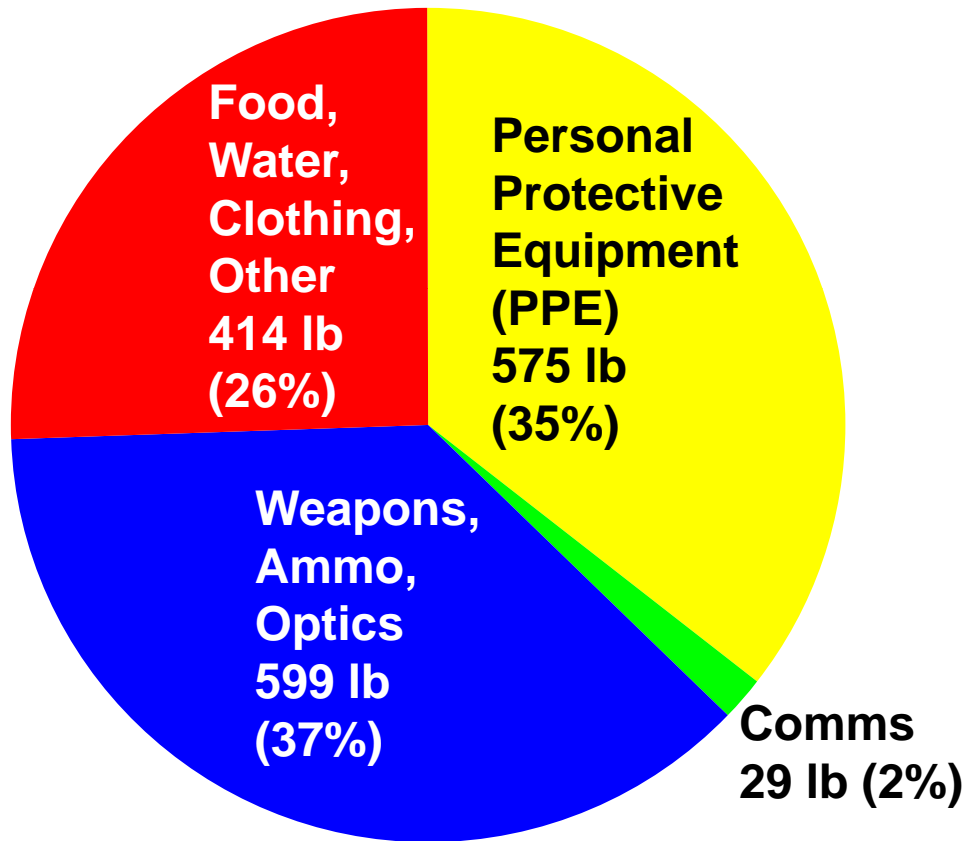
# Individual Assault Load





# Squad Assault Load

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- **Total squad load w/Corpsman  
~1,620 lb**
- **Squad load  
~900 lb more than  
recommended**



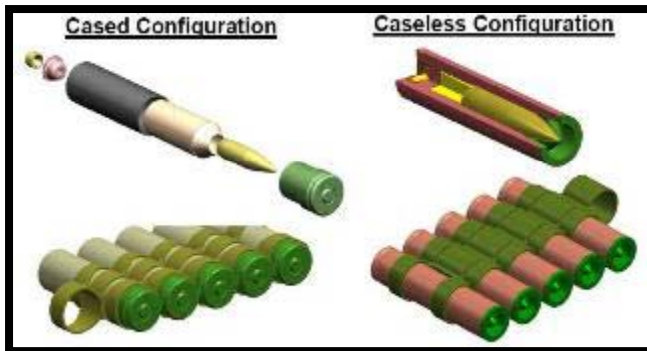
# Top Level Findings

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- Individual Marine assault load varies from about 97 to 135 lb vs. 50 lb recommended maximum
- Total Squad Assault load is about 1,620 lb, about 900 lb over recommended maximum Squad load
- Squad and individual equipment are designed and procured independently and are not considered as a system
- Most optimistic outcome of all S&T efforts may result in:
  - ~ 300 lb potential weight savings per squad
  - ~ 300 lb potential weight transfer per squad
  - ~ 300 lb that still needs to be carried or eliminated through tactics
- Over-matching threats exist and will persist
- PM MERS does not have the directive authority, capability or resources necessary to execute systems engineering process



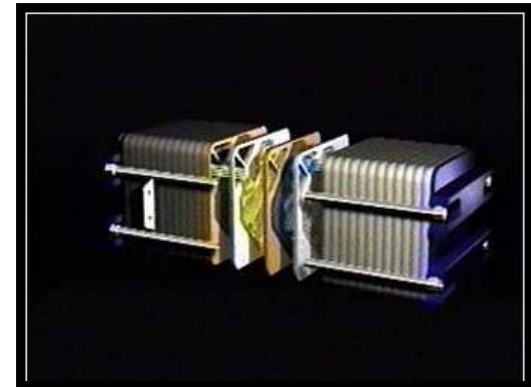
# Lightening the Load



Future Ammunition



Future Rifleman



Future Fuel Cell



# Reducing the Weight: Investment

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- **ONR**
  - \$33M in 40 programs (Marine as a system, power, sensors and electronics, warrior performance and protection, and materials)
- **Army**
  - ~\$75M for PPE, comms, power, weapons, ammo, food human performance
- **DARPA**
  - Funding levels undetermined
  - Power, load transfer and human performance
- **Navy and Air Force**
  - Funding levels undetermined
  - Load consideration for Corpsmen, Riverine Ops, Seabees, Security

**Lightening the Load is about 1% of the DOD S&T Investment**





# Reducing the Weight: S&T Forecast

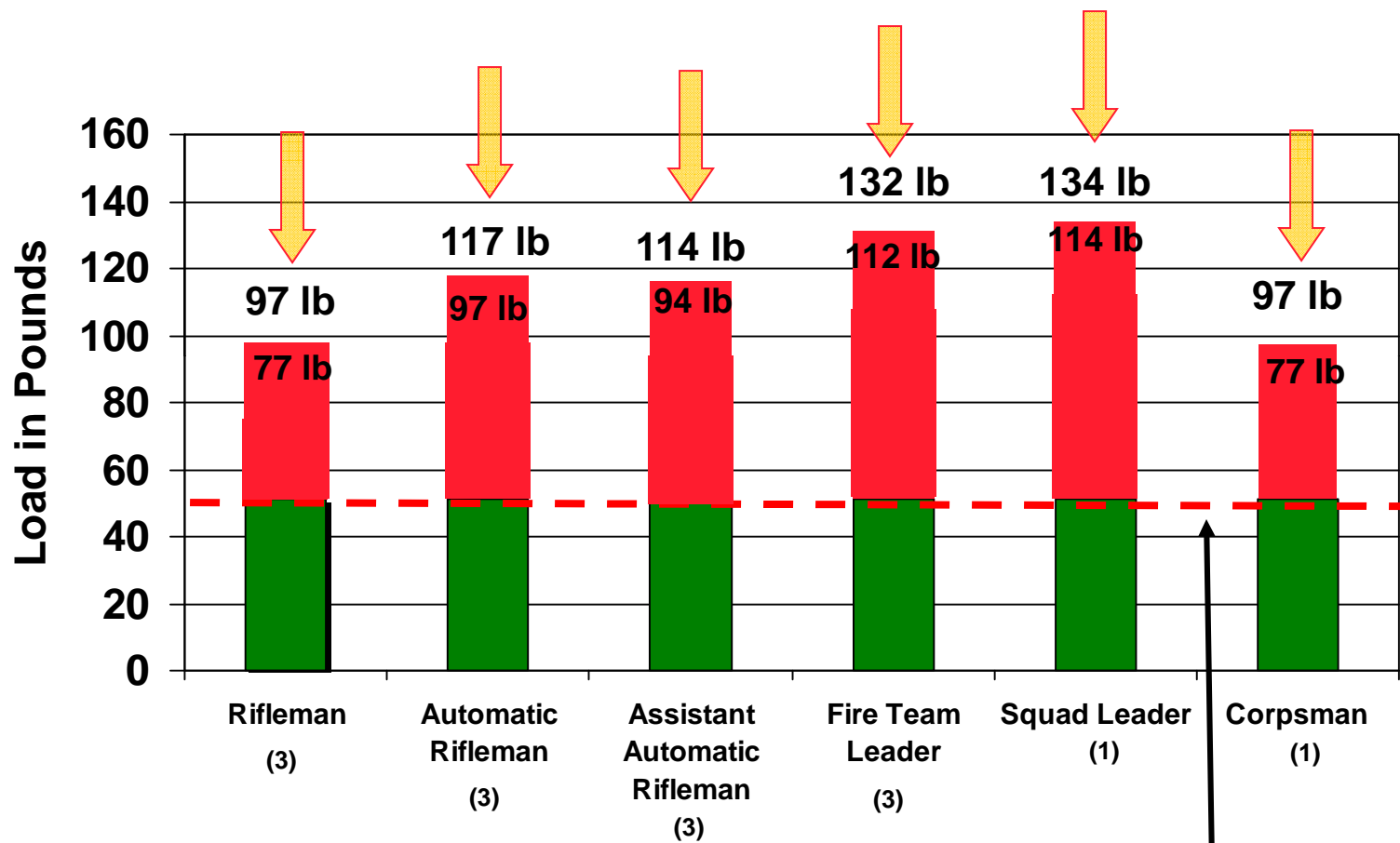
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Category	~ Individual Weight Savings
PPE – Advanced Materials (nanotechnology)	4 to 6 lb
Weapons and Ammo – Caseless Ammo and Lightweight Weapon	5 lb
Integrated Optics	3 to 7 lb
Overall Marine Systems Integration	2 lb
Advanced Batteries	1+ lb

**Possible Savings of ~ 10 to 20 pounds per Marine(~300 per squad but would still be ~ 600 pounds overweight)**



# S&T Weight Reduction Potential



**Squad remains ~ 600 lb overloaded**

50 lb  
Recommended  
Assault Load



# Transferring The Load





# Transferring the Load: Offload

## (14) Squad Members

Gas Mask ~6 lb

MREs ~4 lb

Gortex ~4 lb

Face Paint < 1 lb

Patrol Pack ~2 lb



## (4) Fire Team / Squad Leaders

Gas Mask Voice Adapter < 1 lb

9 of 18 M203 Grenades ~7 lb



## (3) Assistant Automatic Riflemen

1 of 2 Drums 5.56 mm ~7 lb

**Assault Squad can transfer ~ 300 lb**



# Transferring the Load: Offload

## Manned/Unmanned Ground Vehicles

- Marine Corps in process of fielding a manned Internally Transportable Vehicle (ITV)
  - Off-board power and a node in the communications network are considered



- Army/DARPA/Allies have invested heavily in unmanned followers and mules

- Provide small unit leaders organic access







# Transferring the Load: Offload

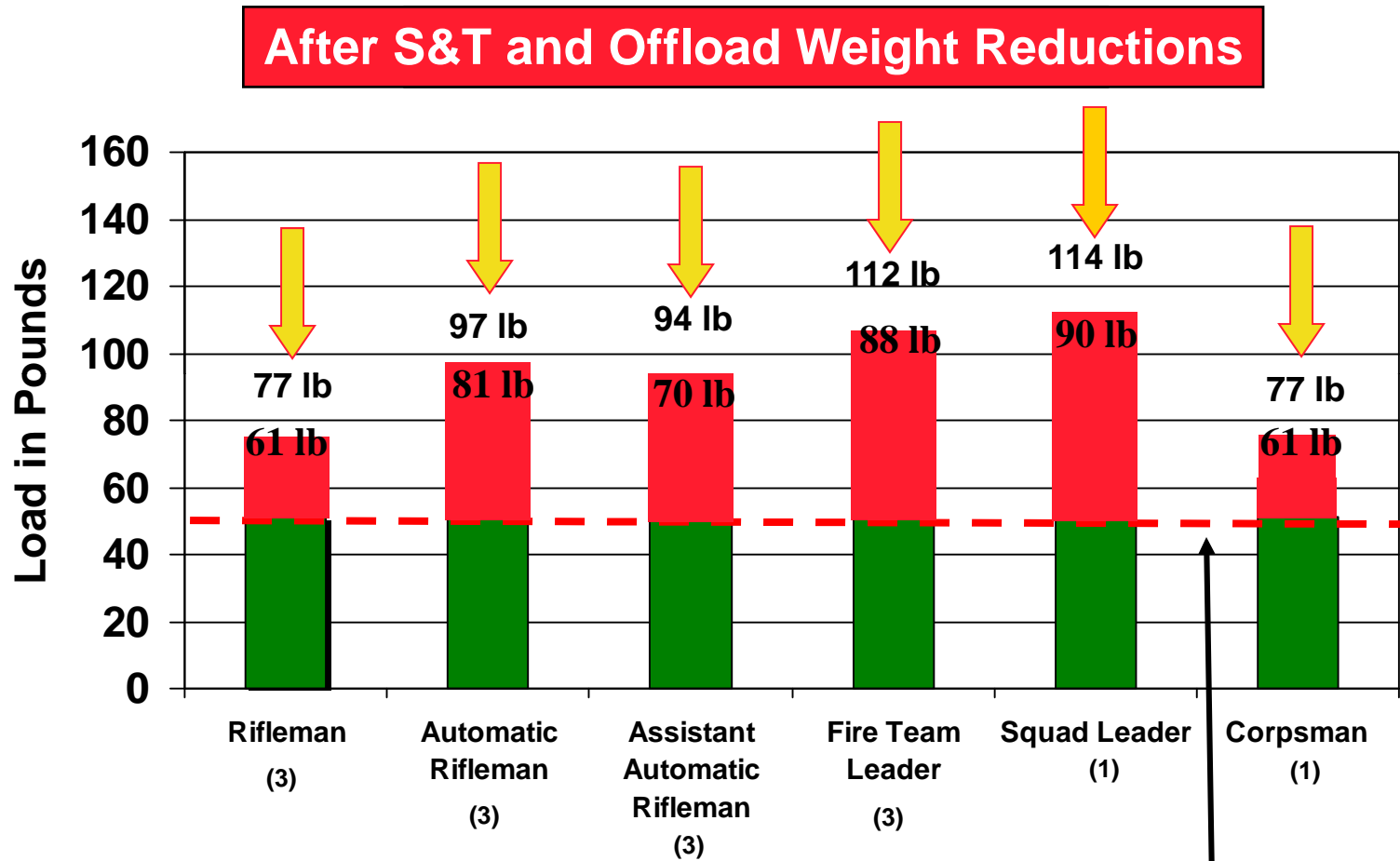
## Manned/Unmanned Aviation Vehicles

- Marine aviation has capability to provide direct support to small units – limited by number of platforms
  - Support designated squads as primary customers
- Navy/Army/DARPA are investing in unmanned air vehicles for cargo loads of 30 to 300 lb





# Offload Weight Potential Savings



**Squad remains ~ 300 lb overloaded**

50 lb  
Recommended  
Assault Load

# **NRAC** Enhance Human Performance

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# Enhance Human Performance

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- **Combat effectiveness**

- Impacted by numerous factors, including fatigue, psychological stress, nutrition, environmental conditions, etc.

- **Physiological Models and Metrics**

- Adequate models do not exist that incorporate combat effectiveness parameters and predict human performance



# Enhance Human Performance: Options

- Nutrition
  - First Strike Rations provide more calories and carbohydrates to boost energy
  - Caffeine supplements now included in MREs
  - Other supplements (tyrosine, quercetin, etc.) are being studied
- Physical training
  - Functionally designed to address operational environment
  - Tailored to individual
- Ergonomics
  - Research programs to balance the load and assess fatigue contribute to understanding the decrements in performance



**Nutrition, ergonomics and physical training...only marginal difference**





## Enhance Human Performance: Tactics & Training

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- Advanced tactical concepts (e.g. Combat Hunter) may permit reducing the combat load
- Early indications point to a possible reduction in squad operational risk
  - Presents an opportunity to reduce weight that compensates for risk
- Advanced immersive training simulators will further advance tactical changes
  - Presents high fidelity conditions that enable higher standards for performance
  - Provides further opportunities to decrease risk induced weight burdens





# A Fundamental Change To Lighten The Load Is Needed!

(More game changing concepts like “Combat Hunter”)

To further reduce squad weight in the near term,  
and accommodate changing needs without  
increasing weight.



## An Example: Game Changing Concept

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- A Squad that can rapidly:
  - Find the enemy through advanced ISR in complex terrain
  - Fix the enemy location with precision
  - Finish the enemy (organically or with other resources)

...can then decrease their load

...and accommodate new challenges without increasing individual Marine weight

**Weight ↓ = ↑ Performance**



## Game Changing Concept (cont'd)

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- Current sequential development process is ineffective...Change is needed!
- Requires a new approach to systems development
  - Parallel / integrated development of tactics, technology and training; experimentation; iteration
  - System level models to allow tradeoffs between weight and other squad combat performance variables...and to design experiments

**“Game changing approaches require game changing processes.”**



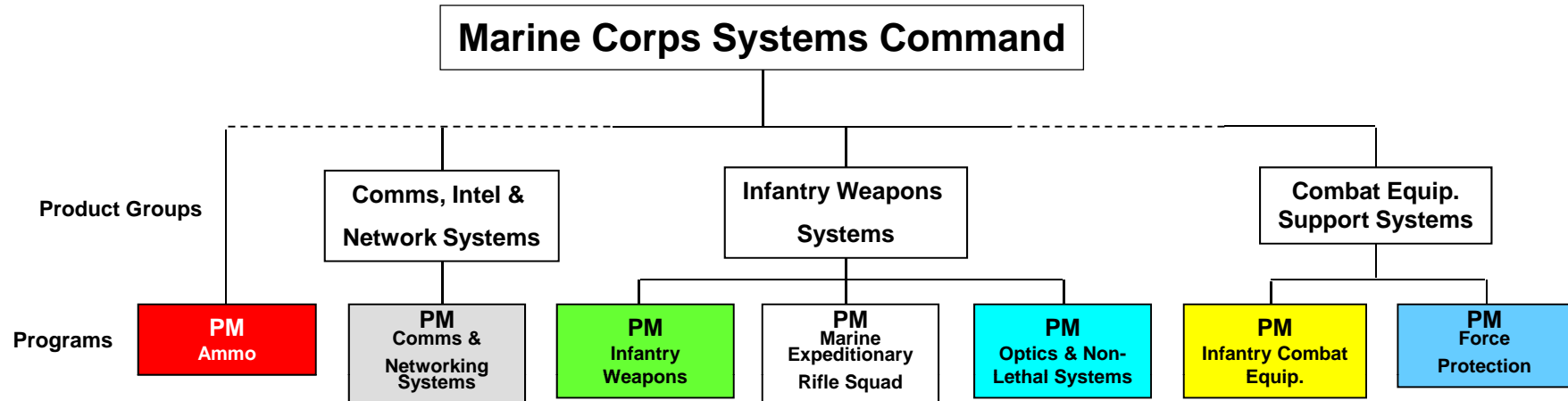
# Systems Approach

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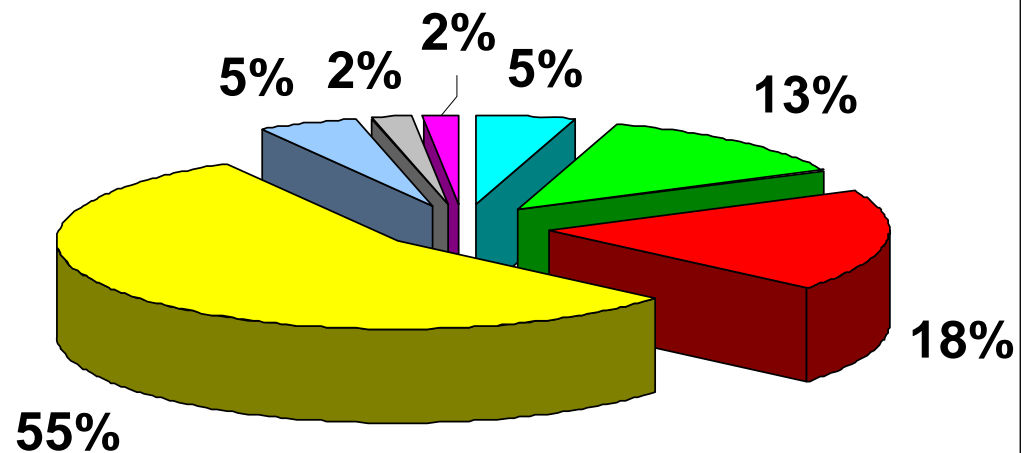


# Current Acquisition Approach



- Seven program managers contribute to squad equipment/weight
- PM MERS was created to provide systems engineering for the squad
- Systems engineering “drives the balanced development of systems products”

MCSC Distribution of Weight





# Marine Rifleman

Lightweight Kevlar  
Helmet

Ballistic Eye Protection

Hydration Device  
with Water  
Purification System

Fire Retardant  
Gloves

First Aid Kit

Fragmentation Grenades  
Smoke Grenade  
M16 Magazines

Bayonet Scabbard

Knee Pads

Combat Boots

AN/PVS-14 Night Vision

Personal Radio  
( Headset and Radio)

Ballistic Hearing Protection

Tactical Vest  
w/Small Arms Protection  
Inserts (PPE)

Rifle Combat Optic

Elbow Pads

AN/PEQ-2A Laser Pointer

M16A4 Rifle  
w/ Sling

M9 Bayonet

Digital Camouflage  
Uniform

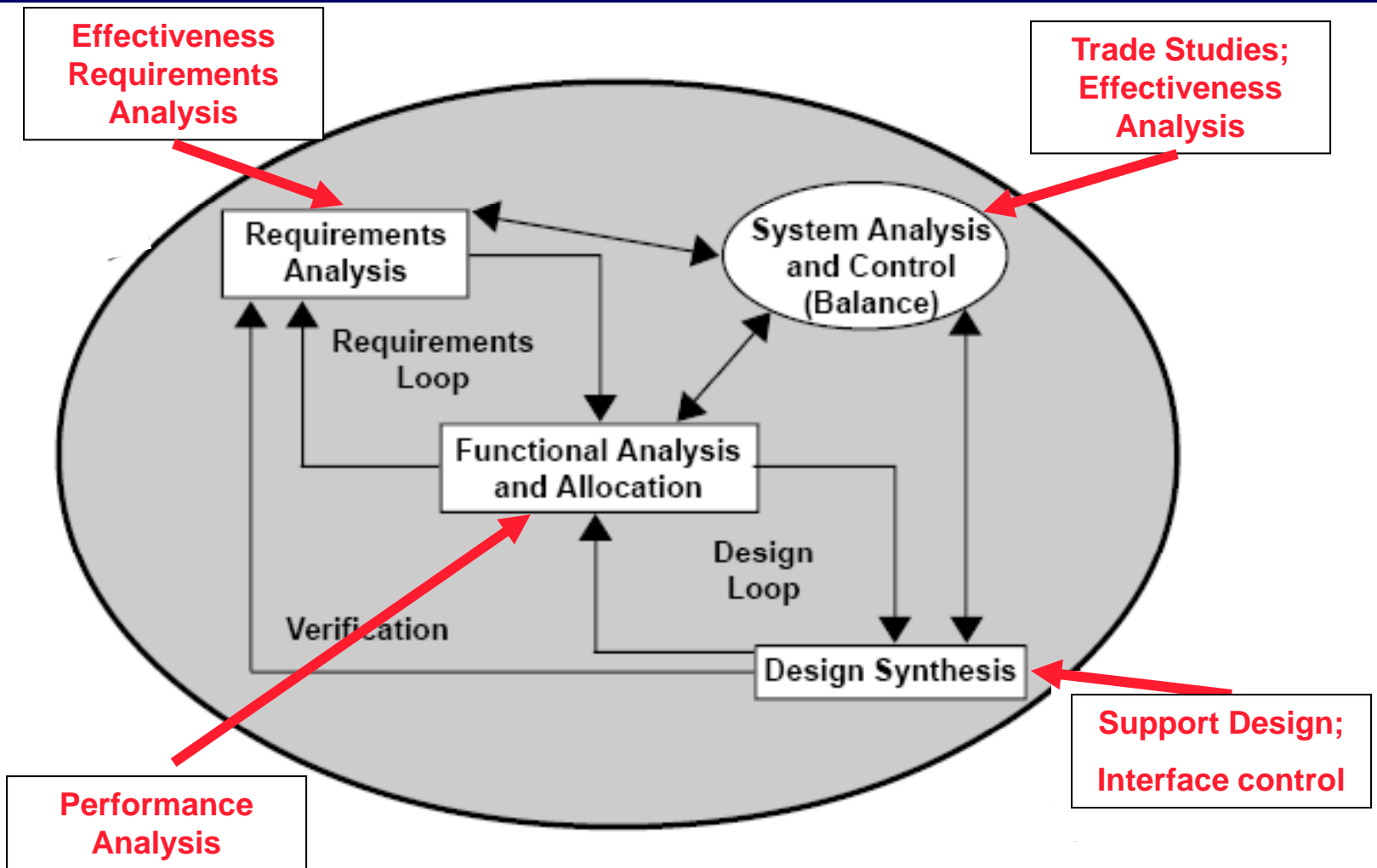
Not Shown:

- Grip Pod on M16A4
- Cooling Vest
- Fire Resistant Balaclava
- Load Bearing Equipment
- Gas Mask

November 2006



# Systems Engineering Process



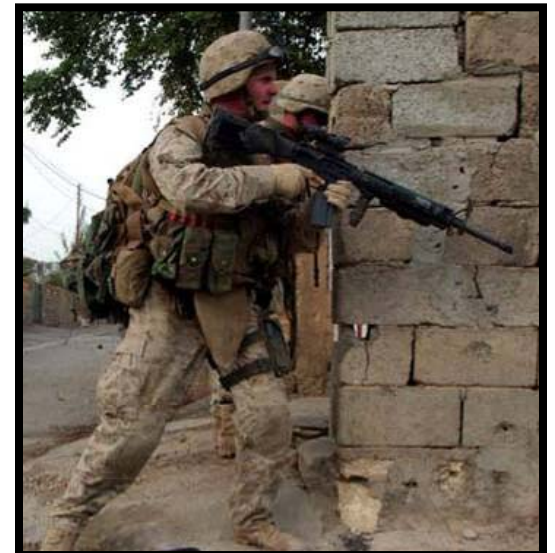
- Modeling and Simulation Tools to support Systems Engineering Process are inadequate
- Very limited experimental data available



# Systems Approach: Findings

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- PM MERS does not have the directive authority necessary to execute an effective systems engineering process
- Data and system level models are needed for development of requirements and implementation of systems engineering process
- Data and system level models on relationship of squad equipment weights to mission effectiveness – **do not exist**
- PM MERS is unable to conduct trade-off analysis to reduce squad load and/or increase squad effectiveness. Areas include:
  - Weapons (range, accuracy)
  - Survivability
  - Mobility
  - Sensors / situation awareness
  - Logistic responsiveness
  - Immediate fires





# Present and Future Trade-Offs

**Dedicated ISR**



**Helmet Integration including  
Fused Optics**

**Lighter Weapon using  
Caseless Ammunition**

**Lighter Body Armor**

**Single Power Source  
Weapons  
Marine**

**Integrated, Multi-Band  
Communications**



**Physical and Operational Training**

**Performance Enhancement  
Supplements Available**



**Dedicated Assault  
Support / Resupply**



**MULE with Battery  
Recharging and Comm Hub  
Capability**



# Systems Approach Conclusions

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- **PM MERS** was established as a program office to ***institute systems integration*** but has not fully matured due to a ***lack of authority, resources, and capabilities***
- ***Reductions in weight*** will not be realized without a ***systems engineering approach***
- ***A disciplined systems engineering approach is mandatory*** as we move toward the future Marine and introduce new capabilities into the squad as a system
- ***Trades of weight vs. new capabilities*** must be conducted to ensure projected weight reductions ***enabled through S&T and weight transfer*** are not eroded





# Recommendations & Actions

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# Recommendations

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- **Science & Technology**

- Protect current investment – IT IS THE FOUNDATION
- Increase Marine Corps engagement with ONR and interaction with DARPA
- Increase efforts to reduce load and improve Marine Rifle Squad lethality, survivability, mobility and training

- **Models**

- Assess impact of load on individual combat effectiveness
- Perform Marine / Squad system level trade offs
- Provide Small Unit Leaders load planning tools to assess impact of load, environment, physiological status on combat effectiveness

- **Experiments**

- Collect data required to populate, calibrate the models
- Conduct Limited Objectives Experiments (LOE) focused directly on tactical concepts and support technologies to reduce squad weight
- Concurrently analyze training and future technologies required to implement promising concepts

- **Management**

- Recognize and develop Marine Rifle Squad as a system



# Actions

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- **ASN (RDA)**
  - Increase ONR investment in Lightening the Load
  - Advocate appropriately funded, multi-service S&T program for Lightening the Load with DDRE
- **CMC**
  - Engage with the Director DARPA to nominate Program Managers and Marine Liaison Officer
  - Establish partnership with DARPA on advanced ISR, lethality, tactics to reduce weight, improve survivability and combat effectiveness
- **DC CD&I**
  - Establish maximum load weights for the Marine and the Rifle Squad
  - Ensure Integration Divisions and MCWL are effectively coordinating with ONR
  - Annually review all Marine Corps programs at ONR
- **COMMARCORSYSCOM**
  - Assign total “Squad as a System” management authority to PM MERS
  - Provide resources to create effective “Squad as a System” systems engineering capability
- **CNR / VCNR**
  - Develop, validate and deliver three models to MARCORSYSCOM:
    - Squad combat effectiveness as a function of load, terrain, environment and other pertinent parameters
    - Impact of load on individual performance (endurance, mobility, combat effectiveness, etc.)
    - Models for system trade of studies (ISR capability, lethality, weight, mobility, survivability, etc.)
  - Capitalize on all unmanned vehicle developments to satisfy organic needs of the Marine Rifle Squad



***“We were ordered to wear everything everywhere in the mountains all the time...Even if you were in great shape, you couldn’t keep up with the enemy.”***



- Commanding Officer,  
1<sup>st</sup> Bn, 3<sup>rd</sup> Marines  
14 Nov 2006



***“Ounces equal pounds and pounds equal pain.”***

- Marine Corps NCO Lessons Learned Conference August 2005